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Transportation Test With Potatoes Under Heater And Ventilation Service, w/ Grand Forks, N. D., To Points In Texas - April, 1949

By

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Beltsville, Maryland

Transportation Test with Potatoes under Heater and Ventilation Service - Grand Forks, N. D. to Points in Texas - April 1949.

Potatoes shipped during the winter from northern points to destinations in the South often involve rather complicated problems in protective services. Different types of protective service may be required during such a single movement, that is heating, ventilation or a combination of both. Shippers are especially concerned with freezing and other transit damage to seed potatoes that are moved from the Red River Valley to points in Texas and other southern states during the winter months, and the problem of preventing freezing damage to shipments of table stock is always present during cold weather. Because of this, it was considered desirable to conduct this test and study the performance of newly available equipment and also the efficiency of the protective services used. Although it was very late in the heater season when this test was planned, cold weather still prevailed in the shipping area and this provided an opportunity to compare the operation of a new mechanical system with different types of combination heater and ventilation services, and of types of heaters. This test, therefore, was essentially a continuation of one just previously completed with the Thermo-King mechanical refrigeration and heating units and the Luminator-Mitchell underslung charcoal heater used with shipments of apples. 1/ Due to delay in getting the special cars back from the last test, the date of loading was a week later than originally planned and by then the weather had warmed up considerably and was less suitable for the purpose of the test. Commercial shipments were not being made so that it became necessary to use shipments of Government purchased potatoes if the test was to be run. Through the cooperation of the Commodity Credit Corporation, 4 carloads were thus made available. They were for delivery to Austin, Waco and Paris, Texas. Additional C. C. C. shipments would have been available in a few days but due to the rapid advent of warm weather it was decided not to wait for them.

The objects of the test as finally composed were: (1) to compare the results obtained from the controlled conditions provided by the Thermo-King units with a combination CPS (Carriers' Protective Service) - controlled ventilation service, a CPS-KVC (Keep vents closed service) to Kansas City and standard vent beyond, and regular CPS: and (2) to determine the effects of using individual floor pads on bruising of potatoes in bottom layer bags.

Summary of Results

The mechanical units maintained temperatures fairly satisfactorily, although there was a greater temperature variation through the load than was obtained in an earlier test with apple shipments from Wenatchee, Wash. to Chicago. Three possible reasons for this are: (1) reduced air velocity of the auxiliary fan; (2) uneven distribution of the air from the duct; or (3) to shifting of the load. Keeping vents closed from origin to destination resulted in much lower and more uniform commodity temperatures than when the vents were opened under CPS rules. In fan cars when ventilation service was used, operation of the fans was of little advantage. While the severe shifting of the load in Car A and slight shifting in Car B resulted in much more severe bruising than usually encountered, there was evidence that the individual pads reduced the amount of floor bruising. The side wall strips in Car A caused bruising damage in sacks in contact with them.

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Equipment Tested

The cars and heaters tested together with type of service used are listed below followed by a statement regarding the heaters and their installation.

Code No.	Car No.	Type Car	Heater	Service
A	WFEX 67564	Standard	Thermo-King Mechanical	Special - 45° commodity temp.
B	FGEX 40,000	Fan	Luminator-Mitchell charcoal with thermostatic control	CPS - controlled ventilation
C	BREX 74698	Fan	Preco Thermo. Alcohol	CPS-KVC Kansas City, Std. ventilation beyond
D	FGEX 56215	Standard	Simplex Thermo. Charcoal	CPS

All of the cars contained 3" of insulation in the walls and ends and 3-1/2" in the floor and ceiling except Car A which had 4-4-1/2" respectively. Cars A and D were wood sheathed, car B aluminum and car C steel sheathed. A and D had 4-1/2" floor racks while B and C had 7-1/2" racks. Car B contained Thermal-Blister thermometers and Car C was equipped with Liquidometers. (BREX 74698 was used only as a standard end bunker fan car although it is also equipped with an underslung heater which was not used.)

The Thermo-King mechanical refrigerating and heating units have been described in the report of the previous heater test. 2/ A few minor changes had been made. These were: (1) the original motor driving the auxiliary fan was replaced with another motor having only 2/3 the speed. This was because the original motor was found to have drawn too high a current and was being re-wound; (2) the two large fuel tanks that had been shown in the previous test to be inadequately vented were replaced by one tank of 97 gallon capacity equipped with gage and vent pipe; (3) the air duct along the car ceiling was replaced with one having no openings on the underside (the bottom openings on the original duct were covered during the previous test). As in the previous test, the Thermo-King units were at the rear of the car as placed in the train.

The Luminator-Mitchell underslung heater with heat exchanger was fully described in the previous report. 2/ No change was made for this test. The Preco thermostatically controlled alcohol heater and the Simplex Thermo-charcoal heater were also described fully in previous reports. 3/

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3/ Comprehensive Report on Heater Tests, issued July 1948 (AAR-USDA Tests 22, 23, 24, 25, 26, and 27)

Commodity and Air Temperatures

Ten commodity and two air temperatures were obtained by means of distant reading electric resistance thermometers. The positions at which these were placed in the load in the previous test were used with slight modifications as follows:

Position	Designation
Bottom bunker east side, head and rear	BBES-H, BBES-R
Top bunker center line, head and rear	TBCL-H, TBCL-R
Bottom quarter, center line, head	BQCL-H
Top quarter, center line, head and rear	TQCL-H, TQCL-R
Top doorway, center line	TDCL
Bottom doorway east side, head and rear	BDES-H, BDES-R
Top liquidometer bulb position (air)	
Bottom liquidometer bulb position (air)	

Commodity temperatures were obtained by resistance thermometers inserted into a potato in the center of the bag about 8 inches from the top. In Car B, equipped with the underslung heater, two positions were used at the bottom doorway east side, one over the inlet end of the pipe coil (rear) and one over the outlet end (head) in order to determine the effects of the drop in temperature from one end of the coil to the other. In order to make comparisons between the average commodity temperatures in all the cars these positions were also used in the cars not so equipped. The thermometers for simulating Liquidometer or blister air temperatures were placed adjacent to the Liquidometer or blister positions. Here again, this position was used in all cars. Top air position was 1 inch below the ceiling, centerline of the car at the doorway except in the Thermo-King car in which it was placed about 1 inch below the air duct at the same position. The bottom position was under the floor rack near the centerline at the doorway. For this test, instead of two bottom blisters at the door posts, only one was used at the center line doorway position because of previous unsatisfactory results with the original placement. Glass fruit-thermometers were placed adjacent to the thermostats of the Preco heaters in the bunkers of Car C to obtain bunker air temperatures. Commodity and air temperatures were read at terminals and other stops en route.

A Ryan recording thermometer was placed near the end of the duct in the Thermo-King car to record delivery air temperatures and another placed in the path of the return air at the bottom of the bulkhead in the unit end of the car. This latter thermograph failed to function, so no record was obtained. A Ryan was also placed under the floorracks adjacent to the bottom Liquidometer position in Car B, and one was placed over each Preco heater to record full burning operation.

Loading and Routing

The cars were loaded at Manvel, N. D. on March 31 under fairly mild conditions. Complete loading data on all cars is shown in table 1. Car C was loaded from trucks on an open platform while the others were loaded directly from storage houses. Because of the mild weather pre-heating of the cars was not necessary. All cars were loaded in the same way with 450 bags, as shown in figure 1. This type of load is most commonly used in this area, and differs somewhat from the standard "pyramid through load." The 5 bag width for the bottom layer is used in winter shipments to provide an air space along the wall at the floor to minimize the danger from freezing.

The potatoes were all of U. S. No. 1 grade. They were still practically dormant but showed signs of beginning to sprout.

In order to determine the value of floor pads in preventing bruising in bags placed on the floor, the bottom layer of sacks in the rear half of each car was placed on individual "Jiffy" pads. These pads were filled with shredded paper and were approximately 1/2" thick. A number of sacks from each end of a car were inspected upon unloading.

The Thermo-King units were started immediately after loading. The thermostat was set at 45° F. Since it was desired to obtain as much heater performance data as possible under the mild conditions expected, this temperature was selected rather than a lower one. The underslung heater was lit after loading even though heat was not required in the car. This was done to further test the operation of the heat exchanger. The cars were assembled in Grand Forks the next morning at which time the portable heaters were installed in the other cars. The Preco heaters were lit and the thermostats set at 42-1/2°. The test train departed at 10:40 A.M. The cars were routed as shown in table 1. All cars were kept together to Denison, Texas, where Car D was detached for delivery to Paris and Car B was transferred to the Southern Pacific for delivery to Abercrombie. Therefore, it was unavailable for reading for two days (figure 3). The trip log is shown in table 2. Total elapsed time for the trip was 137 hours 15 minutes, of which 53 hours 47 minutes (39.1%) was running and 83 hours 28 minutes (60.9%) was standing. This was due to terminal delays which are greater in a north-south movement of this type than is normally experienced in west-east transcontinental traffic.

Discussion of Results

Outside temperatures at loading ranged from 16° F. to 40° with fairly cool weather for the first two days en route. After that it became steadily warmer until a maximum of 84° was reached on April 6 (see fig. 2).

Between the time of loading at Manvel and the make up of the test train, Cars A and B received a terrific impact, apparently during switching. This was first discovered when Car A was entered at Fargo to check on the thermostat bulbs. The entire rear of the car was clear for 4 or 5 feet, the load having been shifted to the other end by the impact. While the load in Car B was in good order the rear fan was found to be inoperative because of binding, and a leak had developed in the heating coil in the car with the result that most of the liquid was subsequently lost. Upon inspection at unloading it was found that the floor racks had moved about 2 inches thereby tearing the fan housing loose and throwing it out of line. To prevent short circuiting the air, the cleared floor space in Car A was covered with one layer of bags at Willmar, and the bags containing the thermometer bulbs which had been moved out of place were replaced as nearly as possible.

In Car A (Thermo-King) top commodity temperatures rose rapidly during the night following loading (fig. 2). The reason for this rise above the thermostat setting is not known, but air temperatures declined after leaving Grand Forks as shown in table 3. Average top commodity temperatures remained at approximately 48°F. until Pacific Junction when the thermostats were lowered 3° to bring the temperatures down to the desired 45°. As there was little drop in commodity temperature by the next morning at Kansas City a further lowering of 2° was made. For the balance of the trip the car averaged between 43° and 44°. There was considerable variation in temperature in the various parts of the load. There are 3 possible explanations for this:

(1) Short circuiting of the air as a result of the shifting of the load despite having covered the empty space with one layer of bags at Willmar.
(2) Uneven distribution of the air from the duct. A differential of from 4 to 8°F. between the TBCL-H and TQCL-H positions (table 3) indicates that a greater part of the air from the end of the duct moved along the ceiling to the end and then down on the top bunker position. Appropriate deflection of the air might possibly have provided a more adequate distribution.
(3) Reduced air velocity owing to the use of the lower speed motor driving the auxiliary fan.

No mechanical troubles were encountered with either of the units other than the unexplained action of the thermostats after loading. These thermostats were the same temporary ones used in the apple test and had not been calibrated since installation in the car. Fuel consumption was not obtained because of failure of the fuel gage and the lack of facilities for measuring the quantity of gasoline required to refill the tank at destination. However, it is estimated that approximately 37 gallons of fuel were consumed with a total of 75 hours operation for both units. This gives an average fuel consumption of .5 gallons per hour per unit, which is about the same as on the apple test. A complete log of operation en route is found in table 7.

Car B (Luminator-Mitchell underslung heater) was moved under CPS rules with controlled ventilation. Heat was to be applied if necessary in heater territory and vents to remain closed throughout the transit period. Because of the mild conditions and commodity loading temperatures, no attempt was made to put heat into the car. However, in order to further test the operation of the heat exchanger or dissipator, the thermostatic control valve was moved to the closed position and the heater lit immediately after loading was completed. The heater was operated as far as St. Cloud or about 30 hours. The heat exchanger functioned satisfactorily during that time (table 8). It was planned to operate the fans to destination, but because of damage to the rear fan housing from the heavy impact at Grand Forks it was shut off at Fargo. The head fan was shut off at St. Cloud and the car was operated from there on as a standard non-fan car. Commodity temperatures rose slowly during the first day. The average top and bottom temperatures were about the same while the fans were on (fig. 3). Thereafter, the spread between the two rose gradually until there was a 6.3° difference at unloading. As shown by the curves in the figure, by keeping the vents closed the total average temperature rise was only 12.3° even though outside temperatures rose 63° en route. Because the car was routed via Southern Pacific from Denison, Texas, to Austin (Abercrombie) it was not possible to follow it and take readings for 61-1/2 hours or until it was spotted for unloading. Complete temperature data are found in table 4.

In order to determine the effects of heater service using automatic thermostatically controlled alcohol heaters in official heater territory with vents kept closed, combined with ventilation after leaving such territory, the Preco heaters in Car C were lighted at Grand Forks. As with Car A, a 45° commodity temperature was desired and the thermostats set one position below this, or 42-1/2°. This setting was used to reduce danger of overheating during the numerous periods when the car would be standing and the fans inactive en route to Kansas City. As the potato temperatures at loading averaged 40°, bunker air temperatures were below the 42-1/2° setting and both heaters were on full burning for some time during the first day (fig. 4). This caused an initial rise in commodity temperatures to about 47° after which they remained fairly constant until warm weather was encountered on April 5 after the vents had been opened. A log of the heater operation is found in table 9. The heaters were on full burning an estimated 18-1/2 hours with a total fuel consumption of 3.72 gallons. The vents were opened at Kansas City and remained open to destination. After warm weather was encountered, commodity temperatures rose rapidly with a considerable spread between the maximum and minimum in spite of the fan operation. At unloading average top commodity temperatures were 65° in Car C as compared with 58° in Car B. This shows the value of keeping vents closed to maintain more desirable temperatures in a movement of this type. There appeared to be no advantage in operating the fans with the vents open as the temperature spread in this car at unloading was as great as in the non-fan Car D. Table 5 contains the complete temperature data.

Car D was moved under regular CPS rules for heating and ventilation. Therefore, the Simplex Thermo-charcoal heaters were not lit and vents were opened first at Willmar when outside air temperatures rose above 40°. They were closed at the next inspection point (Sioux City) when the air temperature was down to 28°. They were reopened at Pacific Junction and remained open to destination at Paris, Texas (fig. 5). Commodity temperatures remained fairly constant from loading until the vents were first opened when the cool air on the night of April 2 dropped the bottom temperatures about 4°. There was little change thereafter until the warm weather on the 5th when all temperatures rose steadily until unloading. Top and bottom temperatures tended to equalize under vent, when running, but spread apart when standing as at Paris (table 6). As in Car C greater advantage of the initial cool temperatures could be taken by keeping vents closed after warm weather is encountered as was done with Car B. This is especially important for movements from north to south at this season of the year.

The Liquidometer and Thermal-Blister readings together with comparable resistance thermometer readings are found in table 10. Previous tests had shown that the Liquidometer readings were in close agreement with the comparable resistance thermometer readings but that the blister readings, especially the bottom, were not. Therefore, prior to this test the two bottom blisters were replaced with one adjacent to the doorway centerline position under the floor racks. This resulted in a much closer agreement, averaging about 2-1/2° lower than the comparable resistance thermometer. However, the average of the top blister readings was about 4° lower than the comparable resistance thermometer. The average of the Liquidometer readings was in close agreement with the resistance thermometers during the Wenatchee test (averaging 1° lower, top and bottom) but showed a greater divergence during this test, (averaging 3° lower for the top and 1.7° lower for the bottom). As the same equipment was used for both tests the reason for change is not understood.

The influence of pads on severity of bruising is given in table 11. In judging severity of bruising, potatoes which were classed as having severe bruising were those which were damaged to such an extent that they would have little or no market value. Potatoes classed as having moderate bruising were those which were considered to have some value but would have to be sold at a discount. Because of the excessive shifting of the load in Car A, a considerable amount of bruising in bottom bags was found at unloading. Most of the shifting occurred in the end containing the floor pads resulting in many of the bags being moved clear off the pads. As a result there was a very high percentage of severe bruising. While the unpadded bags showed less shifting than the padded ones, there was a slightly higher percentage of severe bruising, showing that even under these extreme conditions the pads were of some value. In Car B, which had a much smaller amount of shifting from the impact, the floor bruising was also found to be quite high although less than one half that of Car A. One bag inspected was found to be half off its pad which would account for its rather high percentage of severe bruising. Again there was a slight advantage in using the pads as shown in the table. In Car C, which appeared to have normal handling, there was 3 times the amount of severe bruising when the bags were placed directly on the floor racks, showing a definite advantage of using the pads. Side wall chafing was found to be severe in many in-

stances in Car A where bags were against the wall rack strips. Severe bruising against the sidewalls was also noted in one instance (table 11) in Car B. Although no detailed inspection was made on Car D, chafing was not noted in bottom layer bags where the pads were used but it was noted in 10 bags directly on the floor. Therefore pads, although shown to be of some value, were not completely effective in reducing floor bruising, especially when there was shifting of the load or other evidence of rough handling as in Cars A and B. In such cases many bags slid partly or completely off the pads. Even when there was no evidence of rough handling of the car as in Car C, the bags flattened out in transit and occupied more area than the pads so that many potatoes were in contact with the floor racks. Similar results in the reduction but not complete elimination of floor bruising by pads has been noticed on new crop California potatoes by Barger, Shear, and Morris 4/. On the other hand, Smith and Shear 5/ found pads very effective with Idaho Russet potatoes and Ryall and Shear 6/ found them very effective with Bermuda onions. The possibility of bags of potatoes shifting off individual pads in transit has been pointed out by Smith and Shear. The same manufacturers that made the individual pads used in this test make larger pads of similar material in which 8 pads cover the entire floor of a car (56 individual bag pads are required per car). These larger pads would be preferable to the individual pads for protection from floor bruising but they probably would impair air circulation.

The type of load used in this test seemed to have 4 rather serious drawbacks: (1) Starting the bottom bags about 6 inches from the bottom of the bunker so as to have the first stack lean slightly toward the bunker allows a total of about 12 inches slack space for endwise shift. (See figure 1.) Smith and Shear observed this same fault; (2) Having the doorway 6 layers high with the rest of the load 7 high does not provide as good doorway bracing as a 7 layer doorway would; (3) Having some of the bags against the sidewalls permits bruising (see table 11, Car B); (4) In many instances it was observed that bags from the second layer had worked themselves down into the air space which had been left along the sidewalls as a protection against freezing. These bags would be quite subject to freezing damage in cold weather. These faults could be corrected by following the recommendations for loading in Bulletin No. 43 of the AAR Freight Container Bureau.

4/ Barger, W. R., Shear, E. V., and Morris, L. I. The Prevention of Mechanical Injury During Transit on New-Crop Potatoes. Calif. Agr. Expt. Sta. Unnumbered Rpt. 7 pp. illus. 1945.

5/ Smith, Edwin and Shear, E. V. Potato Shipping Studies in 1942-43 Eastern Idaho Districts, USDA H. T. & S. Office Report No. 121, 1943.

6/ Ryall. A. Lloyd and Shear, E. V. Heavy Loading and the Use of Excelsior Pads in the Shipment of Bermuda Onions. USDA H. T. & S. Office Report No. 139, 1944.

Acknowledgments

This test was made possible by the companies, agencies, and individuals listed below whose cooperation and assistance is gratefully acknowledged.

The commercial loads of potatoes were supplied by the Commodity Credit Corporation, and were obtained from Clarence Holverson, Clifford Knudson, and Stadstad and Cox, Manvel, North Dakota.

Assistance in making local arrangements in securing the test cars of potatoes was furnished by Mr. W. M. Case, Executive Secretary of the Red River Valley Potato Growers Association, Grand Forks, N. D. and the Grand Forks, N. D. Office of the Production and Marketing Administration.

The arrangements for handling the test cars were made by Keith Erricson, Agent, Western Fruit Express, Grand Forks, N. D.

The business cars for the accommodation of the test party were furnished by the Great Northern Railway and the Missouri Pacific Lines. These roads, the C. B. & Q. and the Kansas, Oklahoma and Gulf and the Texas and Pacific Railroads provided the necessary extra handling of the business cars and the 4 test cars.

Assistance in arranging for unloading at Austin was given by A. R. Fox, Passenger Agent, and H. J. Holzman, Freight Agent, Missouri Pacific Lines.

The Thermo-King Car and standard non-fan car were furnished by the Western Fruit Express Company, and the underslung heater car and fan car by the Burlington Refrigerator Express Company.

The Thermo-King units were installed and serviced by the U. S. Thermo Control Company, Minneapolis.

The members of the test party, who also supervised the loading and unloading of the test cars, were:

A. A. Hamer, Western Fruit Express Co., Alexandria, Va.
W. A. Nutty, Association of American Railroads, Chicago, Ill.
V. W. Snyder, U. S. Thermo Control Co., Minneapolis, Minn.
J. M. Lutz, BPISAE, USDA, East Grand Forks, Minn.
W. H. Redit, BPISAE, USDA, Beltsville, Md.

The following accompanied the test between the points indicated and assisted in the conduct of the test:

L. H. Brown, American Refrigerator Transit Co., St. Louis, Mo.-
Kansas City - Austin
F. L. Yeater, Ass't. to General Supt. Transportation, MOP Lines-
Kansas City - Austin
W. A. Carpenter, Vice President and General Mgr., K. O. & G. RR.-
Muskogee, Okla - Denison, Texas
J. M. Sims, Traveling Car Service Agent, MOP Lines, Houston
Ft. Worth - Austin

U. S. D. A. HEATER TEST NO. 49-2

LOADING DATA-TABLE NO. 1

Car	A	B	C	D
Number	WFE 67564	FGE 40,000	BRE 74698	FGE 56215
Type	Special	Fan	Fan	Non-Fan
Heater	Thermo-King	Luminator-Mitchell underslung	Preco-alcohol	Simplex-Thermo. charcoal
Shipper	Clifford Knudson Manvel, N. D.	Clifford Knudson Manvel, N. D.	Clarence Holverson Manvel, N. D.	Stadstad & Cox Manvel, N. D.
Consignee	Austin State School Austin, Tex.	Austin State Hospital Abercrombie, Tex.	McLenan Co. School Bd. Waco, Tex.	Lamar Co. Schools Paris, Tex.
Routing	GN, CB&Q, MOP, KO&G T&P	GN, CB&Q, MPO, KO&G SP,	GN, CB&Q, MOP, KO&G, T&P	GN, CB&Q, MOP, KO&G, T&P
Commodity	Potatoes	Potatoes	Potatoes	Potatoes
Variety	Pontiac	Pontiac	Pontiac	Pontiac
Type loading	Solid	Solid	Solid	Solid
No. Bags (100 lbs.)	450	450	450	450
Billed wt. lbs.	45,000	45,000	45,000	45,000
No. stacks (1)	10	10	10	10
No. rows (2)	5 & 6	5 & 6	5 & 6	5 & 6
Layers	7	7	7	7
Individual pads	Rear end	Rear end & doorway	Rear end & doorway	Rear end
Height of load	71"	71"	71"	67"
Space above load	20"	20"	20"	20"
Sidewall space (2)	0 - 14"	0 - 17"	0 - 8"	0 - 14"
Sidewall flues or racks	Racks	Flues	None	None
Height of floor racks	4-1/2"	7-1/2"	7-1/2"	4-3/4"
Loading				
Started	10:30 A.M.	1:15 P.M.	9:10 A.M.	9:45 A.M.
Completed	12:05 P.M.	3:00 P.M.	11:35 A.M.	11:20 A.M.
Average temperatures				
Outside air	33°	36°	30°	30°
Commodity	40°	40°	39°	40°

(1) 5 stacks each end (except Car A - 4 stacks A end, 6 in B end) 50 bags crosswise in doorway.

(2) Bottom and top layer 5 wide - others 6 wide. Sidewall spacing varied accordingly.

TABLE NO. 2

U. S. D. A. TEST NO. 49-2

TRIP LOG

Date	Station	Time Arrived	Time Departed	Elapsed Time Running	Elapsed Time Standing
April 1	Grand Forks, N. D.	-	10:40 AM		
	Hillsboro	11:45A	12:15P	1-05	30
	Fargo	1:15P	4:15	1-00	3-00
	Barnesville, Minn.	5:15	5:30	1-00	15
	Evansville	7:15	7:30	1-45	15
1-2	St. Cloud	10:00	7:40A	2-30	9-40
2	Paynesville	8:55A	9:15	1-15	20
	Willmar	10:15	6:10P	1-00	7-55
	Marshal	8:10P	8:15	2-00	05
	Ruthton	9:20	9:30	1-05	10
	Ihlen	10:20	11:30P	50	1-10
2-3	Garretson, S. D.	11:55	12:10A	25	15
3	Sioux City, Ia.	3:05A	8:45	2-55	5-40
	Ferry, Neb.	9:00	10:55	15	1-55
	Walthill	11:50	12:01P	55	11
	Fremont	1:25P	2:30	1-24	1-05
	Ashland	3:35	4:05	1-05	30
	Pacific Jct, Ia.	5:25	9:10	1-20	3-45
	Payne	9:55	10:05	45	10
4	St. Joseph, Mo.	12:10A	1:45A	2-05	1-35
	Beverly	2:45	2:55	1-00	10
	Kansas City	3:25	8:40P	30	17-15
	Sheffield	8:50P	8:55	10	05
	Wagstaff, Kan.	10:25	10:30	1-30	05
4-5	Osawatomie	11:20	1:45A	50	2-25
5	Roper	4:00A	4:15	2-15	15
	Coffeyville	6:00	6:35	1-45	35
	Okay, Okla.	8:45	9:05	2-10	20
	Muskogee	10:05	11:45	1-00	1-40
	Henryetta	1:30P	1:50P	1-45	20
	Allen	3:45	4:00	1-55	15
	Tupelo	4:50	5:10	50	20
	Coleman	6:00	6:30	50	30
	Denison, Tex.	7:50	9:50	1-20	2-00
	Sherman	10:25	10:30	35	05
	Whitesboro	11:15	11:25	45	10
6	Ft. Worth	1:20A	9:50A	1-55	8-30
	Penelope	12:05P	12:25P	2-15	20
	Waco	1:00	1:15	35	15
	Mart	1:40	2:35	25	55
	Coymack	3:20	3:50	45	30
	Valley Jct.	4:35	6:40	45	2-05
	Milano	7:20	8:00	40	40
	Rockdale	8:25	8:35	25	10
	MP 217	8:55	9:12	20	17
6-7	Taylor	9:55	2:45A	43	4-50
7	Austin	3:55A		1-10	
			Totals	53-47	83-28
			Total elapsed time	137-15	

Table No. 3

U. S. D. A. Heater Test No. 49-2

Corrected Air and Commodity Temperatures

Commodity Potatoes — Car No. A WFE 67564

Service Automatic control for 45°F. Commodity Temperature — Heater Thermo-King

Station	Date	Time	OST °F	Liquid-ometer Position Top	Liquid-ometer Position Bott.	TBCL H	TQCL H	TDCL	TQCL R	TBCL R	BBES H	BQCL H	BDES H	BDES R	BBES R	MAX.	MIN.	AVE. TOPS	AVE. BOTT
Manvel	3-31	-	-				Loading 10:30 A.M. to 12:05 P.M.												
Manvel	3-31	12:05P	32	410	395	425	420	415	430	425	430	450	430	430	430	45.0	41.5	42.3	43.4
Grand Forks	4-1	9:30A	33	565	450	590	555	515	515	555	465	465	440	480	460	59.0	44.0	54.6	46.2
Fargo	4-1	1:30P	42	475	445	525	535	510	510	535	470	480	445	480	465	53.5	44.5	52.3	46.8
St. Cloud	4-1	10:00P	34	445	435	450	505	490	500	485	460	480	450	470	460	50.5	45.0	48.6	46.4
St. Cloud	4-2	6:30A	24	470	450	460	500	490	500	465	470	485	450	470	460	50.0	45.0	48.3	46.7
Willmar	4-2	10:30A	42	425	445	450	500	495	510	465	475	495	460	480	465	51.0	45.0	48.4	47.5
Willmar	4-2	5:00P	46	460	450	445	500	490	500	465	470	495	460	470	465	50.0	44.5	48.0	47.2
Ihlen	4-2	10:30P	28	460	450	445	495	485	500	465	470	505	460	475	460	50.5	44.5	47.8	47.4
Sioux City	4-3	4:00A	28	470	455	455	495	485	500	470	465	500	465	475	460	50.0	45.5	48.1	47.3
Ferry	4-3	10:00A	44	465	455	460	495	485	500	470	470	510	465	475	465	51.0	46.0	48.2	47.7
Pacific Jct.	4-3	5:30P	50	480	460	465	500	485	500	475	470	515	475	480	470	51.5	46.5	48.5	48.2
St. Joseph	4-4	12:05A	36	420	445	440	495	480	500	465	470	515	470	470	455	51.5	44.0	47.6	47.6
Kansas City	4-4	7:00A	30	460	450	440	495	470	490	465	465	515	470	470	450	51.5	44.0	47.2	47.4
Kansas City	4-4	1:00P	56	405	430	410	490	465	480	455	460	510	470	460	435	51.0	41.0	46.0	46.7
Kansas City	4-4	8:00P	46	405	420	390	480	450	470	435	450	505	460	445	405	50.5	39.0	44.5	45.3
Coffeyville	4-5	6:00A	38	390	415	380	480	440	460	435	440	495	450	440	405	49.5	38.0	43.9	44.6
Muskogee	4-5	11:00A	62	420	420	390	480	435	460	435	435	495	445	440	400	49.5	39.0	44.0	44.3
Denison	4-5	8:00P	60	395	420	380	480	425	445	425	425	485	440	430	395	48.5	38.0	43.1	43.8
Ft. Worth	4-6	7:00A	49	430	415	380	470	420	435	425	415	480	440	430	400	48.0	38.0	42.6	43.3
Waco	4-6	1:00P	84	425	425	385	470	420	435	420	420	490	440	430	400	49.0	38.5	42.6	43.6
Taylor	4-6	10:00P	63	500	460	400	480	430	440	425	420	485	445	435	405	48.5	40.0	43.5	43.8
Austin	4-7	9:00A	66	405	445	390	485	425	440	415	425	495	445	435	410	49.5	39.0	43.1	44.2
Austin	4-7	1:00P	83	435	445	395	490	430	450	420	430	500	455	440	420	50.0	39.5	43.7	44.9

Table No. 4

U. S. D. A. Test No. 49-2

Corrected Air and Commodity Temperatures

Commodity Potatoes
Service CPS - controlled ventilation (KVC)

Car No. B FGE 40,000 Fan Car 1/
Heater Luminator-Mitchell underslung

Station	Date	Time	OST °F.	Liquid-ometer Position Top	Liquid-ometer Position Bott.	TBCL H	TQCL H	TDCL	TQCL R	TBCL R	BBES H	BQCL H	BDES H	BDES R	BBES R	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
Manvel	3-31	-	-					Loading 1:15 - 3:00 P.M.											
Manvel	3-31	3:00P	34	420	420	450	420	430	425	430	415	425	410	425	435	45.0	41.0	43.1	42.2
Grand Forks	4-1	9:30A	33	420	410	445	425	425	430	430	410	425	420	430	435	44.5	41.0	43.1	42.4
Fargo	4-1	1:30P	42	445	435	445	425	425	430	430	425	425	420	425	430	44.5	42.0	43.1	42.5
St. Cloud	4-1	10:00P	34	455	445	465	440	435	435	435	445	440	435	440	440	46.5	43.5	44.2	44.0
St. Cloud	4-2	6:30A	24	435	435	470	440	435	440	445	455	440	440	455	450	47.0	43.5	44.6	44.8
Willmar	4-2	10:30A	42	445	440	470	445	445	445	450	440	445	445	455	455	47.0	44.0	45.1	44.8
Willmar	4-2	5:00P	46	520	445	470	450	445	445	450	450	440	445	455	450	47.0	44.0	45.2	44.87
Ihlen	4-2	10:30P	28	480	445	480	455	450	455	465	450	440	445	450	455	48.0	44.0	46.1	44.87
Sioux City	4-3	4:00A	28	455	440	485	460	455	460	465	450	445	445	455	460	48.5	44.5	46.5	45.14
Ferry	4-3	10:00A	44	450	435	485	460	450	455	460	445	445	440	450	460	48.5	44.0	46.2	44.82
Pacific Jct.	4-3	5:30P	50	495	445	485	460	450	460	465	445	445	435	450	460	48.5	43.5	46.4	44.75
St. Joseph	4-4	12:05A	36	465	460	485	465	455	460	465	450	450	440	455	460	48.5	44.0	46.6	45.12
Kansas City	4-4	7:00A	30	455	445	490	465	455	460	465	450	450	440	450	465	49.0	44.0	46.7	45.10
Kansas City	4-4	1:00P	56	500	445	490	470	460	460	465	450	450	440	450	465	49.0	44.0	46.9	45.17
Kansas City	4-4	8:00P	46	520	465	495	475	465	470	475	455	450	445	455	470	49.5	44.5	47.6	45.50
Coffeyville	4-5	6:00A	38	480	465	505	480	465	480	485	455	460	450	455	470	50.5	45.0	48.3	45.8
Muskogee	4-5	11:00A	62	500	465	505	490	475	480	485	455	460	455	455	480	50.5	45.5	48.7	46.11
Denison	4-5	8:00P	60	550	485	510	500	480	485	490	465	460	455	465	480	51.0	45.5	49.3	46.59
Austin	4-8	9:30A	67	600	530	600	580	560	580	585	515	500	530	525	520	60.0	50.0	58.1	51.83

1/ Note- Due to damage to rear fan it was cut off at Fargo. Head fan cut off at St. Cloud.

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Table No. 5

U. S. D. A. Test No. 49-2

Corrected Air and Commodity Temperatures

Commodity Potatoes

Service - CPS - KVC to Kansas City - Standard ventilation beyond

Car No. C BRE 74698 (Fan)

Heater Preco Alcohol

Station	Date	Time	OST °F.	Liquid-ometer Position Top	Liquid-ometer Position Bott.	TBCL H	TQCL H	TDCL	TQCL R	TBCL R	BBES H	BQCL H	BDES H	BDES R	BBES R	MAX.	MIN.	AVE. TOPS	AVE. BOTT
Manvel	3-31	-	-					Loading 9:10 - 11:35 A.M.											
Manvel	3-31	12:30P	32	395	350	400	410	415	400	395	405	400	400	400	390	41.5	39.0	40.4	39.9
Grand Forks	4-1	9:30A	33	385	365	400	410	400	410	400	400	395	405	395	390	41.0	39.0	40.4	39.7
									Heaters Lit										
Fargo	4-1	1:30P	42	480	425	405	415	420	420	405	405	405	435	405	390	43.5	39.0	41.3	40.8
St. Cloud	4-1	10:00P	34	505	440	430	440	450	465	440	430	410	465	445	410	46.5	41.0	44.5	43.2
St. Cloud	4-2	6:30A	24	460	425	440	460	450	465	450	435	420	465	450	415	46.5	41.5	45.3	43.7
Willmar	4-2	10:30A	42	500	450	450	460	465	470	450	445	430	470	460	430	47.0	43.0	45.9	44.7
Willmar	4-2	5:00P	46	545	440	455	470	460	485	470	445	425	470	455	425	48.5	42.5	46.8	44.4
Ihlen	4-2	10:30P	28	490	455	470	480	475	490	485	440	440	475	465	440	49.0	44.0	48.0	45.2
Sioux City	4-3	4:00A	28	475	460	480	485	480	495	490	430	450	485	475	455	49.5	43.0	48.6	45.9
Ferry	4-3	10:00A	44	475	445	470	480	475	485	480	465	445	480	470	450	48.5	44.5	47.8	46.2
Pacific Jct.	4-3	5:30P	50	500	470	480	485	480	495	485	470	455	485	480	460	49.5	45.5	48.5	47.0
St. Joseph	4-4	12:05A	36	485	475	485	495	485	500	490	480	460	495	485	465	50.0	46.0	49.1	47.7
Kansas City	4-4	7:00A	30	485	465	490	495	490	500	495	485	465	495	485	470	50.0	46.5	49.4	48.0
								Heaters extinguished - vents opened											
Kansas City	4-4	1:00P	56	540	465	490	495	490	500	495	485	470	495	485	470	50.0	47.0	49.4	48.1
Kansas City	4-4	8:00P	46	540	470	485	495	490	505	495	485	470	495	480	465	50.5	46.5	49.4	47.9
Coffeyville	4-5	6:00A	38	440	440	485	480	460	485	485	475	460	460	455	465	48.5	45.5	47.9	46.3
Muskogee	4-5	11:00A	62	540	465	485	475	470	485	480	475	460	475	465	465	48.5	46.0	47.9	46.8
Denison	4-5	8:00P	60	620	520	485	550	560	555	525	520	460	565	555	475	56.5	46.0	53.5	51.5
Ft. Worth	4-6	7:00A	49	540	500	505	555	550	555	530	555	475	560	550	490	56.0	47.5	53.9	52.6
Waco	4-6	1:30P	84	720	560	510	600	630	645	615	570	480	620	640	500	64.5	48.0	60.0	56.2
Waco	4-7	7:00A	59	640	540	585	665	630	695	675	585	500	615	615	520	69.5	50.0	65.0	56.7

Table No. 6

U. S. D. A. Test No. 49-2

Corrected Air and Commodity Temperatures

Commodity Potatoes 1/ Car No. D FGE 56215 (Non-Fan)
Service - CPS rules for heat and ventilation Heater Simplex Thermo. - charcoal

Station	Date	Time	OST °F.	Liquid-ometer Position Top	Liquid-ometer Position Bott.	TBCL H	TQCL H	TDCL	TQCL R	TBCL R	BBES H	BQCL H	BDES H	BDES R	BBES R	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
Manvel	3-31	-	-					Loading 9:45 - 11:20 A.M.											
Manvel	3-31	12:30P	32	425	375	455	420	445	440	435	435	435	445	440	410	45.5	41.0	43.9	43.3
Grand Forks	4-1	9:30A	33	420	390	450	420	445	445	450	425	425	430	435	410	45.0	41.0	44.2	42.5
Fargo	4-1	1:30P	42	435	400	450	430	445	445	450	425	435	435	435	415	45.0	41.5	44.4	42.9
St. Cloud	4-1	10:00P	34	460	415	450	430	440	445	450	420	425	425	430	415	45.0	41.5	44.3	42.3
St. Cloud	4-2	6:30A	24	430	410	460	430	445	455	460	430	425	430	430	415	46.0	41.5	45.1	42.6
Willmar	4-2	10:30A	42	435	415	460	435	445	455	460	430	430	430	435	415	46.0	41.5	45.1	42.8
Willmar	4-2	11:15A	43						Vents Opened										
Willmar	4-2	5:00P	46	485	440	460	435	445	455	460	430	425	430	435	415	46.0	41.5	45.1	42.7
Ihlen	4-2	10:30P	28	420	345	445	435	440	455	460	395	415	405	420	415	46.0	39.5	44.7	41.0
Sioux City	4-3	4:00A	28	400	340	430	430	425	460	445	360	395	380	405	410	46.0	36.0	43.8	39.0
Sioux City	4-3	4:00A	28						Vents Closed										
Ferry	4-3	10:00A	44	405	350	420	425	420	450	440	365	380	380	400	395	45.0	36.5	43.1	38.4
Pacific Jct.	4-3	5:30P	50	455	390	425	425	420	455	440	370	380	380	400	395	45.5	37.0	43.3	38.5
Pacific Jct.	4-3	5:30P	50						Vents Opened										
St. Joseph	4-4	12:05A	36	410	410	420	425	420	455	440	375	380	385	400	395	45.5	37.5	43.2	38.7
Kansas City	4-4	7:00A	30	400	395	410	420	410	455	430	370	380	380	400	395	45.5	37.0	42.5	38.5
Kansas City	4-4	1:00P	56	490	415	410	420	410	445	430	375	380	380	400	395	44.5	37.5	42.3	38.6
Kansas City	4-4	8:00P	46	500	430	440	430	415	460	445	375	380	385	400	395	46.0	37.5	43.8	38.7
Coffeyville	4-5	6:00A	38	420	400	425	430	420	475	455	395	390	395	405	400	47.5	39.0	44.1	39.7
Moskogee	4-5	11:00A	62	520	465	425	435	420	475	460	430	405	415	420	415	47.5	40.5	44.3	41.7
Denison	4-5	8:00P	60	590	585	460	470	430	515	500	525	435	470	440	420	52.5	42.0	47.5	45.8
Paris	4-6	4:00P	76	740	695	500	515	490	545	540	515	460	475	460	440	54.5	44.0	51.8	47.0
Paris	4-7	7:00A	70	610	535	580	600	540	635	620	535	485	505	505	460	63.5	46.0	59.5	49.8

1/ Heaters not lit because of high outside air temperatures.

Table No. 7

U. S. D. A. Heater Test No. 49-2

Heater Inspection Data

Test Code No. A
Car No. WFEX 57564

Thermostat Setting 45°
Unit Fans

Heater Thermo-King
Placement 2 units A end

Date	Location	Time	Remarks
3/31	Manvel, N. D.	1:30P	Units started after loading. Thermostats set at 45°. Refueled 3:00 P.M.
4/1	Grand Forks	9:00A	High commodity temperatures noted. Top air 56.5°. Bottom air 45.0 (Liquidometer positions).
	Fargo	2:00P	Inspected lading which was found to have shifted 4 to 5 ft. from A end of car. Car apparently received very heavy impact while switching in Grand Forks prior to make-up of train. Bulkhead and floor racks at A end completely clear. Opening in bulkhead over thermostat bulb covered. One battery for B unit broken by impact.
	St. Cloud	10:00P	New battery installed for B unit.
4/2	Willmar	2:00P	Cleared space on floor racks covered one bag deep to prevent short circuiting of air. Thermostat bulbs uncovered at request of factory engineer.
4/3	Pacific Jct.	5:30P	Because of continued high commodity temperatures both thermostats dropped 3° to 42°. A. unit cut off.
4/4	Kansas City	8:00A	Both thermostats dropped 2° to 40°. B unit only operating.
4/6	Taylor, Tex.	10:00P	B unit found with main switch off. Reason unknown. Both units restarted.
4/7	Austin	1:00P	Both units shut off when unloading started.

Total operation: A - 24 hours B - 51 hours
Estimated total fuel consumption - 37 gallons.

Table No. 8

U. S. D. A. Test No. 49-2

Heater Inspection Data

Test Code No. B
Car No. FGE 49,000

Thermostat Setting Closed
Fans On Drains Plugged

Heater Luminator-Mitchell
Placement underslung at doorway

Inspected at	Date	Time	OST °F.	Liquidometer thermo. temp. 1/ Top	Liquidometer thermo. temp. 1/ Bottom	Burner operation	Lbs. fuel added	Lbs. fuel in heater	Total fuel consumed from last inspection	Estimated hrs. main burner on last insp.
Manvel, N. D.	3/31	3:00P	34	42.0	42.0	Lit 2/		20		
Grand Forks	4/1	9:30A	36	42.0	41.0	B	34			
Fargo	4/1	2:00P	42	44.5	43.5	B Rear fan inoperative 3/				
St. Cloud	4/1	10:00P	34	45.5	44.5	B		5	49	31

4/ Heater darkened
Head Fan cut off
Vents left closed to destination

1/ Resistance thermometers in Liquidometer bulb positions.

2/ Heater lighted to check operation of heat dissipator. Thermostat valve remained closed with no heat going into coil in car.

3/ Car B received hard impact at same time as Car A which shifted floor racks and moved rear fan housing out of line causing it to bind. Shock also cracked a pipe in the coil resulting in the loss of the liquid.

4/ It is estimated that heater burned out in short time after closing damper for darkening.

Table No. 9

U. S. D. A. Test No. 49-2

Heater Inspection Data

Test Code No. C
Car No. BRE 74698

Thermostat Setting 42-1/2°
Fans On Drains Open diagonally

Heater Preco Alcohol
Placement Each End

Head-USDA
Rear-WFE 118

Inspected at	Date	Time	OST °F.	Air temperature at thermostat		Burner operation		Gallons fuel added		Gallons fuel in heater		Fuel consumed from last inspection		Estimated hrs. main burner on last insp.	
				H	R	H	R	H	R	H	R	H	R	H	R
Grand Forks, N. D.	4/1	10:00A	36	Both heaters lit		B	B	-	-	2.20	2.25	-	-	-	-
Fargo	4/1	2:00P	42	42.5	42.5	B	B	-	-	-	-				
Barnesville, Minn.	4/1	5:15P	-	42.	44.	B	B	-	-	-	-				
St. Cloud	4/1	10:00P	34	44.	46.	P	P	-	-	1.35	1.55	.85	.70	9.0	6.5
St. Cloud	4/2	6:30A	24	42.	42.	P	PB	-	-	-	-	-	-		
Willmar	4/2							-	-	1.15	1.23				
Willmar	4/2	10:30A	42	44.	44.	P	P	2.20	2.72	3.35	3.95	.20	.32	1.0	2.0
Willmar	4/2	5:00P	46	46.	45.	P	P	-	-	-	-	-	-		
Ihlen	4/2	10:30P	28	45.	44.	P	D (re-lit)		-	-	-	-	-		
Sioux City, Ia.	4/3	4:00A	28	45.	44.	P	P	-	-	-	-	-	-		
Ferry, Neb.	4/3	10:00A	44	44.	44.	P	P	-	-	2.80	3.45	.55	.50	-	-
Pacific Jct., Mo.	4/3	5:30P	50	46.	46.	P	P	-	-	-	-	-	-		
Kansas City	4/4	7:00A	30	45.	46.	P	P			2.60	3.05	.20	.40	-	-
Heaters extinguished and removed									Total			1.80	1.92	10.0	8.5
Vents opened to destination															

Note: B = Full burning P = Pilot only PB = Partial full burning D = Dark

Table No. 10

Car Air Temperatures

Liquidometer, Thermal Blister & Resistance Thermometer Readings

Place	Date	Time	CST	B FGE 40,000				C BRE 74698			
				Thermo-Blister		Res. Thermometer		Liquidometer		Res. Thermometer	
			°F	Top 1/	Bott. 2/	Top 1/	Bott. 2/	Top 1/	Bott. 2/	Top 1/	Bott. 2/
Grand Forks	4/1	10:00A	34	38.0	39.0	42.0	41.0	-	-	-	-
Fargo	4/1	3:00P	42	43.5	42.0	44.5	43.5	46.0	39.5	48.0	42.5
St. Cloud	4/1	10:00P	34	42.0	43.0	45.5	44.5	45.5	42.0	50.5	44.0
St. Cloud	4/2	6:30A	24	40.0	42.0	43.5	43.5	42.0	41.0	46.0	42.5
Willmar	4/2	10:30A	42	40.0	41.0	44.5	44.0	46.0	42.5	50.0	45.0
Willmar	4/2	5:00P	46	48.0	42.0	52.0	44.5	52.0	42.0	54.5	44.0
Ihlen	4/2	10:00P	28	44.0	43.0	48.0	44.5	45.0	43.0	49.0	45.5
Sioux City	4/3	4:00A	28	38.0	39.0	45.5	44.0	44.0	43.5	47.5	46.0
Ferry	4/3	10:00A	44	41.0	45.0	45.0	43.5	45.0	43.5	47.5	44.5
Pacific Jct.	4/3	5:30P	50	45.0	42.0	4[illegible].5	44.5	48.0	45.0	50.0	47.0
St. Joseph	4/4	12:05A	36	43.0	44.0	46.5	46.0	45.5	45.0	48.5	47.5
Kansas City	4/4	7:00A	30	41.0	42.5	45.5	44.5	45.0	45.0	48.5	46.5
Kansas City	4/4	1:00P	56	46.0	42.5	50.0	44.5	51.0	45.0	54.0	46.5
Kansas City	4/4	8:00P	46	48.0	44.0	52.0	46.5	52.0	46.0	54.0	47.0
Coffeyville	4/5	6:00A	38	43.5	44.0	48.0	46.5	40.5	43.5	41.0	44.0
Muskogee	4/5	11:00A	62	48.0	44.0	50.0	46.5	50.0	45.0	54.0	46.5
Denison, Tex.	4/5	8:00P	60	52.0	46.0	55.0	48.5	52.0	49.5	62.0	52.0
Ft. Worth	4/6	7:00A	49	-	-	-	-	5[illegible].5	50.0	54.0	50.0
Waco	4/6	1:30P	84	-	-	-	-	73.0	54.0	72.0	56.0
Waco	4/7	7:00A	59	-	-	-	-	62.0	53.0	64.0	54.0

1/ All top positions - ceiling at centerline doorway position - Blister 3" below ceiling. Liquidometer and resistance thermometer bulbs 1" below ceiling.

2/ Bottom positions - under floor rack near centerline at doorway.

Table No. 11

U. S. D. A. Test No. 49-2

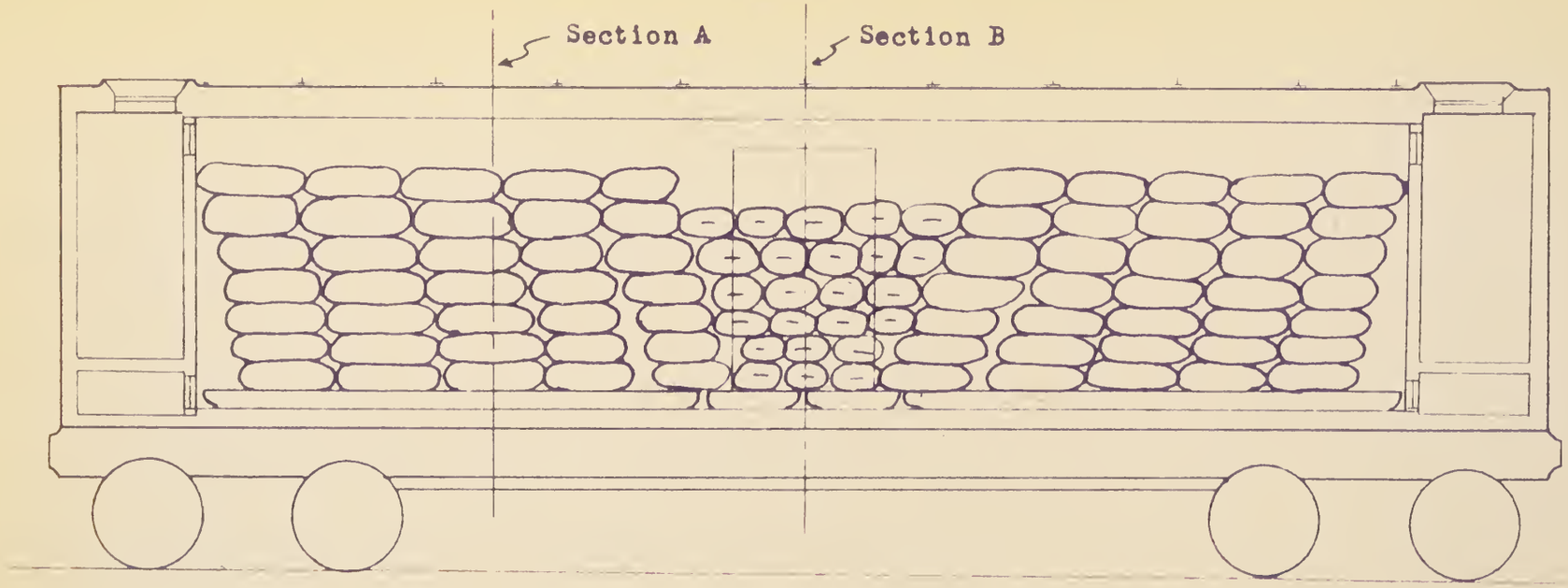
Influence of Pads on Floor Bruising

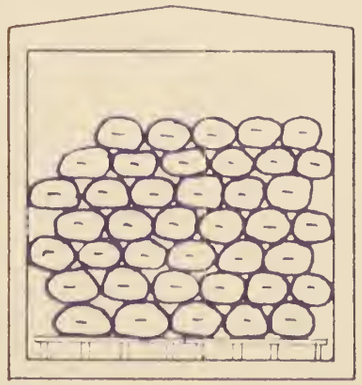
Car	Position (stack from bunker)	Floor Bruising			
		With Pads		Without Pads	
		Severe	Moderate	Severe	Moderate
		%	%	%	%
A. WFEX 67564	5 - centerline	16.2 1/	0.6 1/		
	5 - East side	13.2 1/	5.4 1/	13.5	1.3
	5 - West side	8.3	1.4		
	3 - Centerline			16.2	1.8
	4 - East side			10.7	4.3
	Mean	12.6	2.5	13.5	2.5
B. FGEX 40,000	2 -(4th layer next sidewall)			13.0 3/	1.0 3/
	5 -	3.7	1.4	4.1	0.5
	4 -	8.0 2/	0 2/	4.5	1.1
	2 -	5.1	0		
	3 -			9.6	0.5
	Mean	5.6	0.5	6.1	0.7
C. BREX 74698	5 -	1.5	2.5	3.3	3.3
	5 -	0.4	0.4	1.1	2.5
	5 -	-	-	3.7	1.1
	4 -	0	0	2.2	2.2
	4 -	0.8	0	-	-
	3 -	-	-	2.1	1.7
	2 -	1.2	0.6	2.4	1.7
	2 -	1.2	0.4	-	-
	1 -	0.4	1.5	2.4	0
	1 -	-	-	2.9	1.4
	Mean	0.8	0.8	2.5	1.7

D. FGEX 56215 No detailed inspection. However, chafing was noted on 10 bags without pads and none with those on pads.

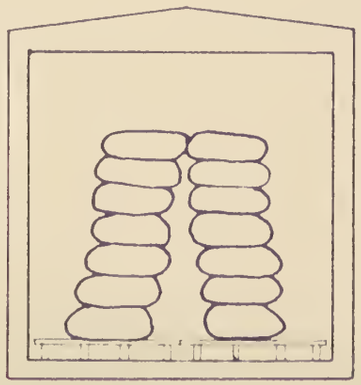
1/ Slid completely off pads.
2/ Slid about 1/2 off pads.
3/ Side wall damage only - bags not on floor - not included in mean.

Figure - 1



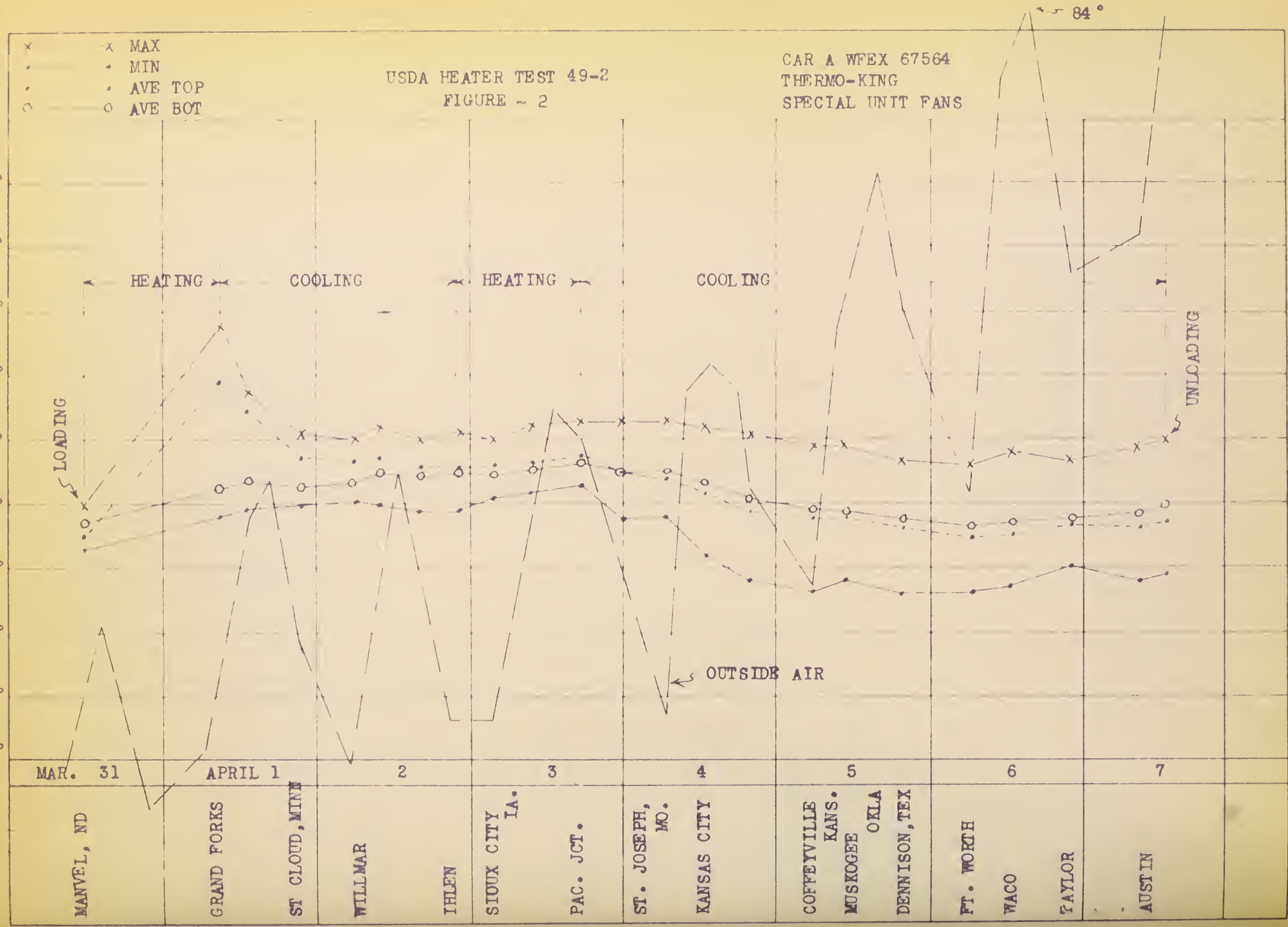


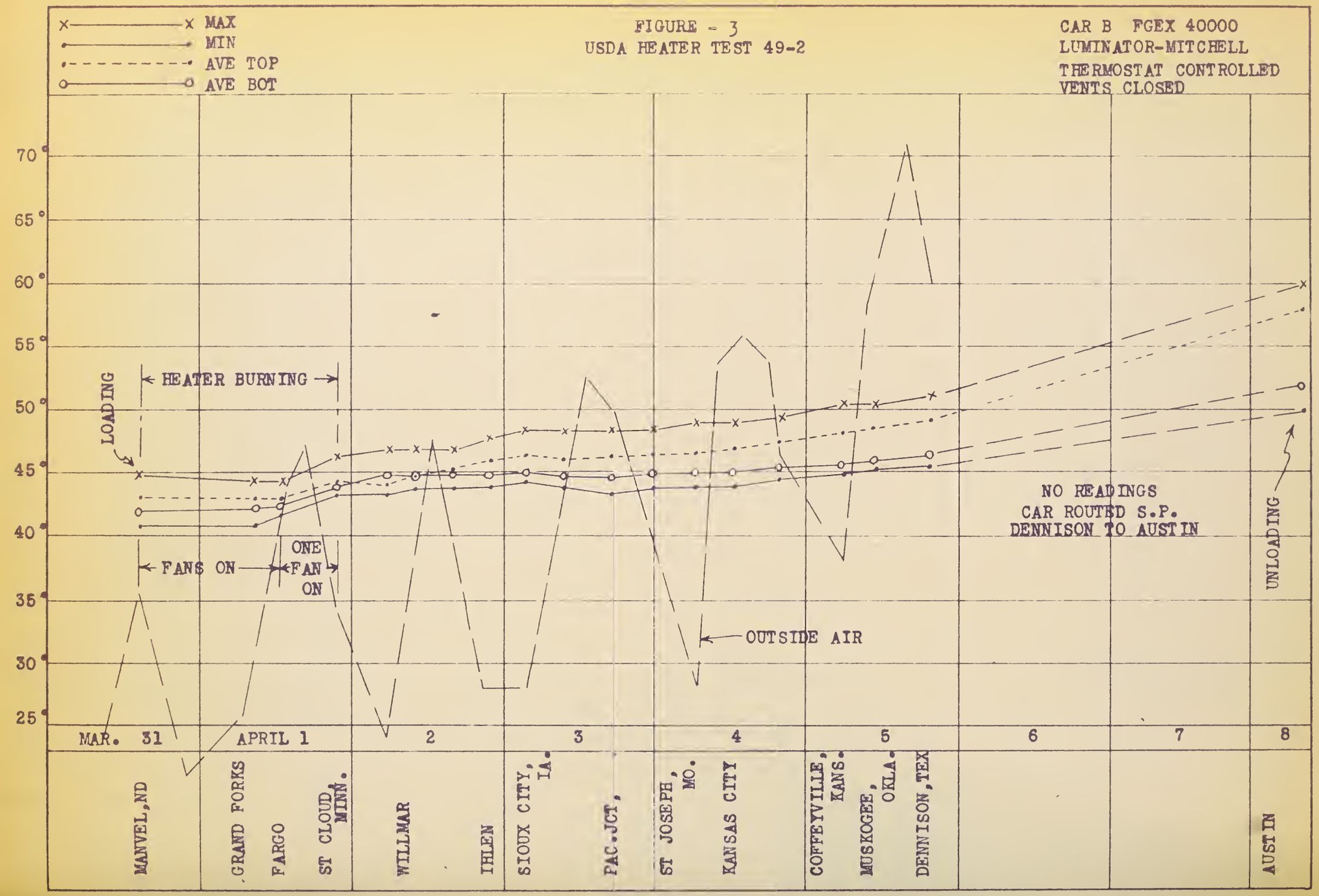
Section A



Section B

Diagram of Test Car Loading


MAX
MIN
AVE TOP
AVE BOT
USDA HEATER TEST 49-2
FIGURE - 2
CAR A WFEX 67564
THERMO-KING
SPECIAL UNIT FANS
84°
70°
65°
60°
55°
50°
45°
40°
35°
30°
25°
HEATING
COOLING
HEATING
COOLING
LOADING
UNLOADING
OUTSIDE AIR
MAR. 31
APRIL 1
2
3
4
5
6
7
MANVEL, ND
GRAND FORKS
ST CLOUD, MINN
WILLMAR
IHLEN
SIOUX CITY IA.
PAC. JCT.
ST. JOSEPH, MO.
KANSAS CITY
COFFEYVILLE KANS.
MUSKOGEE OKLA
DENNISON, TEX
FT. WORTH
WACO
TAYLOR
AUSTIN


MAX
MIN
AVE TOP
AVE BOT
FIGURE - 3
USDA HEATER TEST 49-2
CAR B FGEX 40000
LUMINATOR-MITCHELL
THERMOSTAT CONTROLLED
VENTS CLOSED
70°
65°
60°
55°
50°
45°
40°
35°
30°
25°
LOADING
HEATER BURNING
FANS ON
ONE FAN ON
OUTSIDE AIR
NO READINGS
CAR ROUTED S.P.
DENNISON TO AUSTIN
UNLOADING
MAR. 31
APRIL 1
2
3
4
5
6
7
8
MANVEL, ND
GRAND FORKS
FARGO
ST CLOUD, MINN.
WILLMAR
IHLEN
SIOUX CITY, IA.
PAC. JCT.
ST JOSEPH, MO.
KANSAS CITY
COFFEYVILLE, KANS.
MUSKOGEE, OKLA.
DENNISON, TEX
AUSTIN

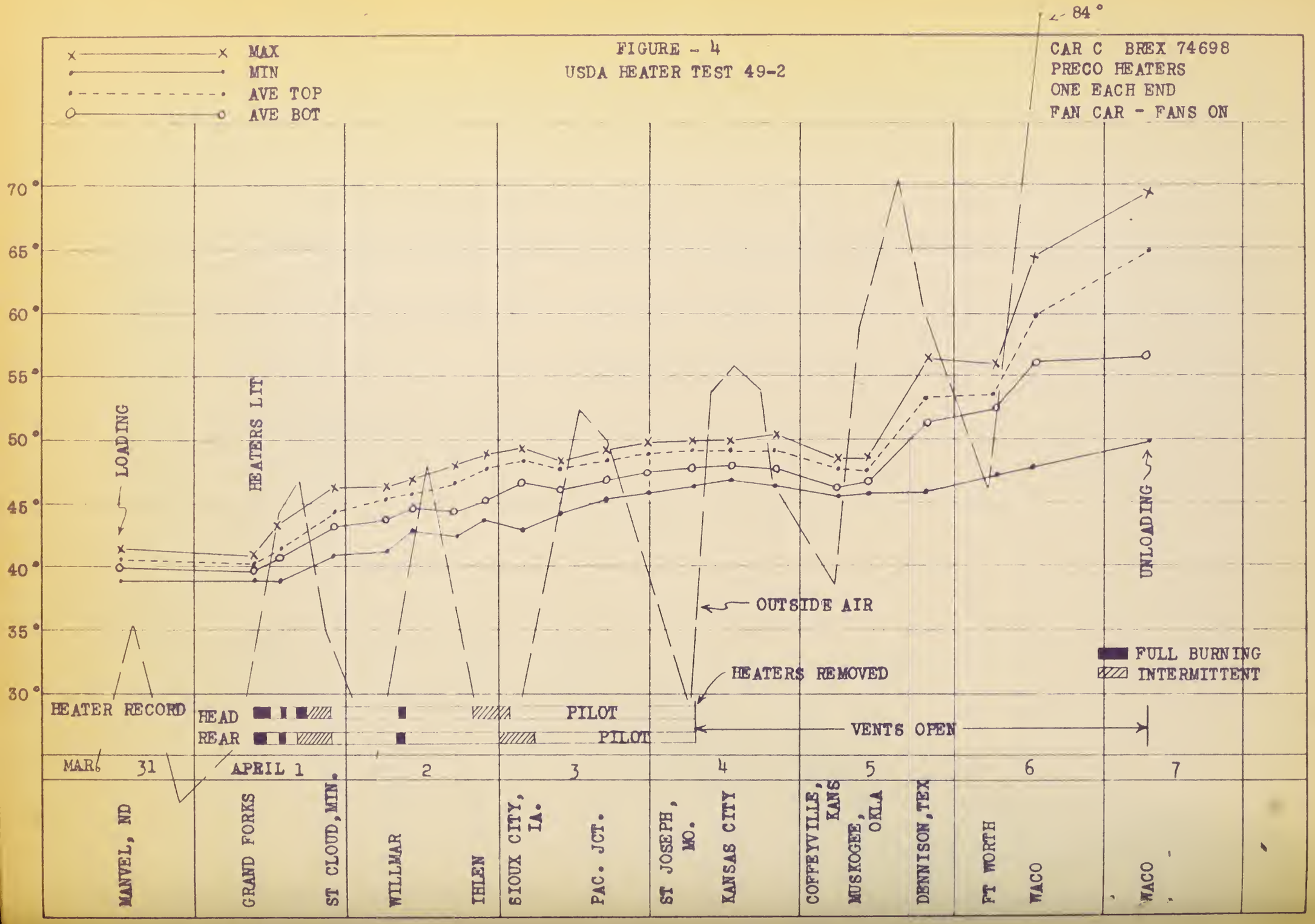
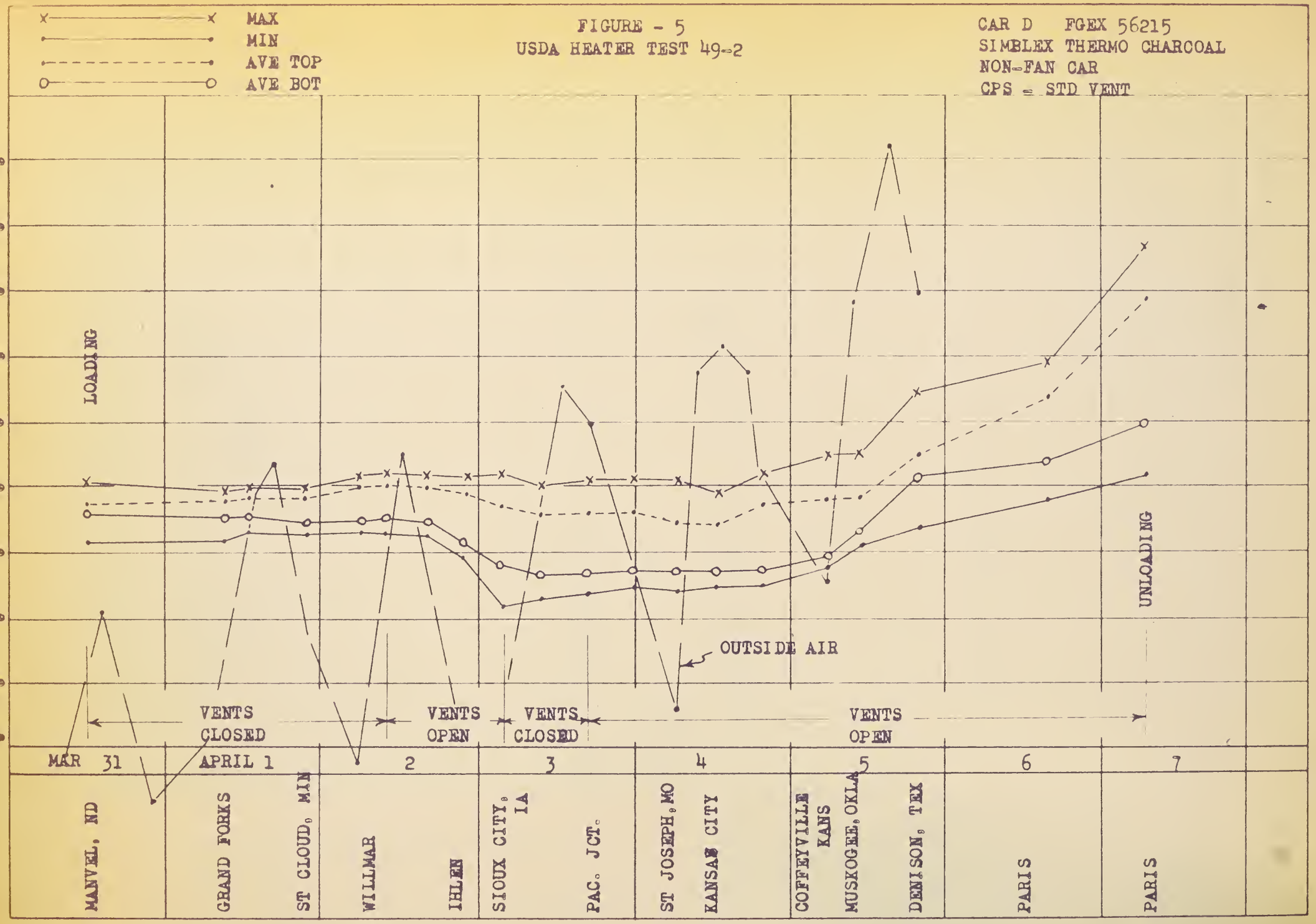


FIGURE - 4
USDA HEATER TEST 49-2
MAX
MIN
AVE TOP
AVE BOT
84°
CAR C BREX 74698
PRECO HEATERS
ONE EACH END
FAN CAR - FANS ON
70°
65°
60°
55°
50°
45°
40°
35°
30°
LOADING
HEATERS LIT
OUTSIDE AIR
HEATERS REMOVED
UNLOADING
FULL BURNING
INTERMITTENT
HEATER RECORD
HEAD
REAR
PILOT
PILOT
VENTS OPEN
MAR. 31
APRIL 1
2
3
4
5
6
7
MANVEL, ND
GRAND FORKS
ST CLOUD, MIN.
WILLMAR
IHLEN
SIOUX CITY, IA.
PAC. JCT.
ST JOSEPH, MO.
KANSAS CITY
COFFEYVILLE, KANS
MUSKOGEE, OKLA
DENNISON, TEX
FT WORTH
WACO
WACO


MAX
MIN
AVE TOP
AVE BOT
FIGURE - 5
USDA HEATER TEST 49-2
CAR D FGEX 56215
SIMBLEX THERMO CHARCOAL
NON-FAN CAR
CPS = STD VENT
70°
65°
60°
55°
50°
45°
40°
35°
30°
25°
LOADING
UNLOADING
OUTSIDE AIR
VENTS CLOSED
VENTS OPEN
VENTS CLOSED
VENTS OPEN
MAR 31
APRIL 1
2
3
4
5
6
7
MANVEL, ND
GRAND FORKS
ST CLOUD, MIN
WILLMAR
IHLEN
SIOUX CITY, IA
PAC. JCT.
ST JOSEPH, MO
KANSAS CITY
COFFEYVILLE KANS
MUSKOGEE, OKLA
DENISON, TEX
PARIS
PARIS